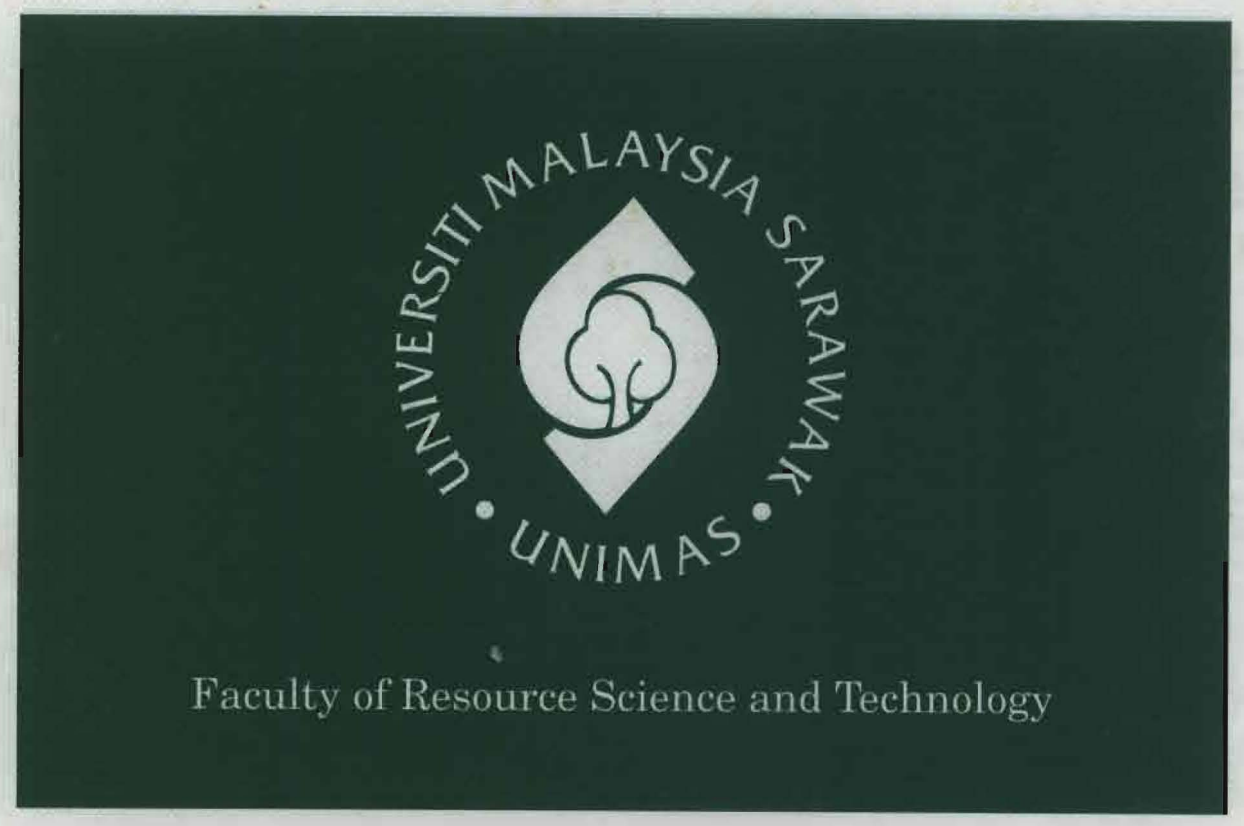

ECOLOGY OF *AMORPHOPHALLUS BORNEENSIS* AT GUNUNG GAYU, PADAWAN

Rosmawatti Binti Zaini

Bachelor of Science With Honours
(Plant Resource and Science Management)
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ROSMAWATTI BINTI ZAINI

This project is submitted in partial fulfillment of
the requirements for the degree of Bachelor of Science with Honours
(Plant Resource Science and Management)

Faculty of Resource Science and Technology
UNIVERSITY MALAYSIA SARAWAK
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ABSTRACK

Distribution of *A. borneensis* was resoluted by using 6 plots of 1 hectare (100m x 100m) and subdivided into 25 subplots (20m x 20m) at Gunung Gayu. The total of *A. borneensis* in 6 plots was 138 plants with mean of 23 plants per hectare. Generally the plants occurred 2 to 4 meter from the large tree such as *Shorea macropyhllum*, *Koompassia excelsa*, *Durio zibethinus* and *Baccaurea macrocarpa*. *A. borneensis* surveyed at Gunung Gayu were ranged between 0.95mm – 20.5mm above ground surface stem diameter with their height ranged between 120.5cm – 180.5cm. The dry weight of 32 plants ranged 4.5g – 660g with the mean of 116.98g. Strong correlation in vegetative part of *A. borneensis* was between height and ground surface stem diameter ($y = 34.41x + 29.80$ which $R^2 = 0.899$). For forest structure in Gunung Gayu, the most dominant species revealed in one hectare plot with the presence of A. *borneensis*, was *Shorea macrophyllum* (IV = 64.21) and the range was followed by *Durio zibethinus* (IV = 21.87), *Baccaurea macrocarpa* (IV = 17.87), *Baccaurea angulata* (IV = 16.73), and *Koompassia excelsa* (IV = 15.18). The mean percentage of sand, which is 82 ± 0.8539% in soil composition, indicates that *A. borneensis* grows in well drained soil which can give well aerated for its root survive.

Key words: Distribution, correlation, dominant species, soil composition.

ABSTRAK

Taburan A. borneensis di kawasan Gunung Gayu telah ditentukan dengan menggunakan 6 plot dengan keluasan satu hektar bagi setiap plot (100m x 100m) dan dibahagikan kepada 25 subplot (20m x 20m). Jumlah keseluruhan A. borneensis bagi 6 plot tersebut adalah 138 individu dengan purata 23 individu dalam 1 hektar. Kebanyakan daripadanya tumbuh dalam jarak antara 2 hingga 4 meter dari pokok-pokok besar seperti Shorea macropyhllum, Koompassia excelsa, Durio zibethinus dan Baccaurea macrocarpa. Diameter batang di permukaan tanah bagi A. borneensis rata-ratanya mempunyai julat di antara 0.95mm – 20.5mm manakala tinggi keseluruhannya pula lebih banyak dalam lingkungan 120.5cm – 180.5cm. Berat kering purata bagi 32 pokok yang mempunyai julat antara 4.5g – 660g ialah 116.98g. Hubungan di antara ketinggian dan diameter batang di permukaan tanah memberikan korelasi yang lebih kuat antara bahagian-bahagian pokok ($y = 34.41x + 29.80$ which $R^2 = 0.8994$). Bagi struktur hutan di Gunung Gayu, spesies yang paling dominan ialah Shorea macrophyllum (IV = 64.21) diikuti oleh *Durio zibethinus* (IV = 21.87), *Baccaurea macrocarpa* (IV = 17.87), *Baccaurea angulata* (IV = 16.73), dan *Koompassia excelsa* (IV = 15.18). *Peratusan pasir sebanyak 82 ± 0.8539% dalam komposisi tanah menunjukkan A. borneensis hidup dengan subur dalam struktur tanah yang mempunyai pengudaraan yang baik bagi menjamin pertumbuhan akarnya.*

Kata kunci: Taburan, korelasi, spesies dominan, komposisi tanah.

INTRODUCTION

According to Christophe Wiart (2000), there are 110 genera and 1800 species of tropical fleshy herbs growing from creeping or tuberous rhizomes or corms. Among them is *Amorphophallus* (Araceae) that comprises of 170 species. Hetterscheid (1994) registered that only 13 species of *Amorphophallus* are found in Borneo where 6 in Sarawak, 3 in Sabah and 4 in Kalimantan. The majority of *Amorphophallus* species seem to be pioneers in disturbed vegetations. Many are found in forest margin, open forest, on (steep) slopes, in disturbed parts of primary forests, and sometime in very exposed parts in limestone karst areas (Hetterscheid, 1994).

Various species of *Amorphophallus* have dietary values of their rhizomes and for cooking ingredient (Christophe, 2000). It is also known as an ornamental plant for certain people. The plant has an underground tuber from which the single leaf arises, followed by the inflorescene. The flowers are minute and borne at the base of the while spadix within an encircling bract or spathe. The flower also functions in attracting the insect and bird which act as pollinators.

The research of this herbaceous plant is less especially in Malaysia. In Sarawak, there is yet no detail study on *Amorphophallus*. This species has a high potential to become extinct from their habitat. The fact is, its habitat always been disturbed by human activities which cause deforestation. An exploitation for its importance value lead to adverse effect to its population. With the increasing rate of habitat destruction due to logging, shifting cultivation, resettlement and infrastructural development, the proposed study is urgently needed in order to understand on

the ecology, biology and possible cultivation of these plants. The result will be essentially used for detail scientific documentation and conservation of the *Amorphophallus* plants.

METHODOLOGY

Study Site

The research was located at Gunung Gayu Padawan. Majority of the people live at this area is Bidayuh. There are mostly farmers that practiced slightly cultivate, planted local fruits species, pepper and other short-term crops.

Distribution and the Growth Pattern of *Amorphophallus borneensis* at Gunung Gayu, Padawan

Distribution of *A. borneensis* was determined by establising six plots of 1 hectare (100m x 100m) and subdivided into 25 subplots (20m x 20m). All *A. borneensis* plants were tagged and their stem circumferences above ground surface as well as their height were measured. In another assessment, 32 plants were randomly severed to determine the growth pattern and biomass allocation of *A. borneensis*. The height or length (m), dry weight and fresh weight (kg) for tuber, stem and leaf, the number of leaflets and leaf area. Subsequently, all the vegetative organ of *A. borneensis* were separated and dried in oven at 60°C in 7 days to determine the total dry weight, leaf weight ratio (LWR), stem weight ratio (SWR), tuber weight ratio (TWR), leaf area ratio (LAR) and specific leaf area (SLA) of the individual plant. The leaf area was verified by using *AT Delta-T Scan* (produce by DELTA-T Devices LTD, England).

Floristic Composition and Total Above Ground Biomass Estimation of Gunung Gayu Forest

One hectare plot (100m x 100m) and subdivided into 25 subplots of 20m x20m was established. All trees with diameter breast height (DBH) ≥ were measured and identified. The total leaf area, basal area relative frequency, relative density and importance value of the tress were determined according to the method described by Brower *et al.* (1990) and Mustafa (1997) as stated below;

Relative frequency (Rf) = 100/Tf x f
Relative density (Rd) = 100/Td x d
Basal area (BA) = $3.14\ (DBH/2)^2$
Relative of dominance (RD) = BA/TBA
Importance value (IV) = Rf + Rd + RD

Whereby, DBH = Diameter of breast height, TBA = Total basal area, Tf = Total frequency, Td = Total dominancy, d = dominancy and f = frequency.

The total above ground biomass of woody plants was estimated by following the allometric formula generated by Yamakura *et al.* (1986);

Biomass estimation = $W_S + W_B + W_L$
W_S = $2.0903 \times 10\text{-}2\ (D^2H)^{0.9813}$
W_B = $0.1192\ W_S^{1.059}$
W_L = $9.146 \times 10^{-2}\ W_{TC}^{0.7266}$

Leaf area (one side, $LAIcm^2$) was estimated by using the following formula, LAI (leaf area index) = $11.67\ W_L^{0.9412}$.

Soil Analysis

For soil analysis, about two kilogram of soil at Gunung Gayu area was sampled. The sample will be send to Agricultural Resource Centre (ARC) Semongok to be analyze chemically which are the pH (Hense, 1971 & Mc Lean, 1986), soil organic carbon (C) (Dewis & Freistes, 1970), nitrogen (N) amount (Anon, 1980 & Beitz, 1974), cation exchange capacity (CEC), calcium (Ca) ion amount, magnesium (Mg), kalium (K), natrium (Na) base saturation (BS) (Anon, 1980) and the percentage of clay, silt and sand.

RESULT AND DISCUSSION

Distribution and Growth Pattern of *Amorphophallus borneensis* at Gunung Gayu, Padawan

Entire Gunung Gayu is a mainly secondary forest comprised of mature dusun planted by the local people. In six plots surveyed, the *A. borneensis* population was considered in low density with mean 23 plants. The total plants was that contributed by 30 plants in plot 1, 20 plants in plot 2, 13 plants in plot 3, 33 plants in plot 4, 15 plants in plot 5 and 27 plants in plot 6 (Figure 1).

The observation along the 6 plots showed that distribution of *A. borneensis* has a different pattern, where some of them grow as an individual plants and some of them grows in a group of two or three. This indicated that the species could be dispersed by some other animals such as birds, porcupines, and insects. Hetterschied (1996) mentioned that, is the occurrence of blue berried species exclusively in the northernmost range of *Amorphophallus*, suggesting dispersal by a particular group of birds restricted to that particular geography.

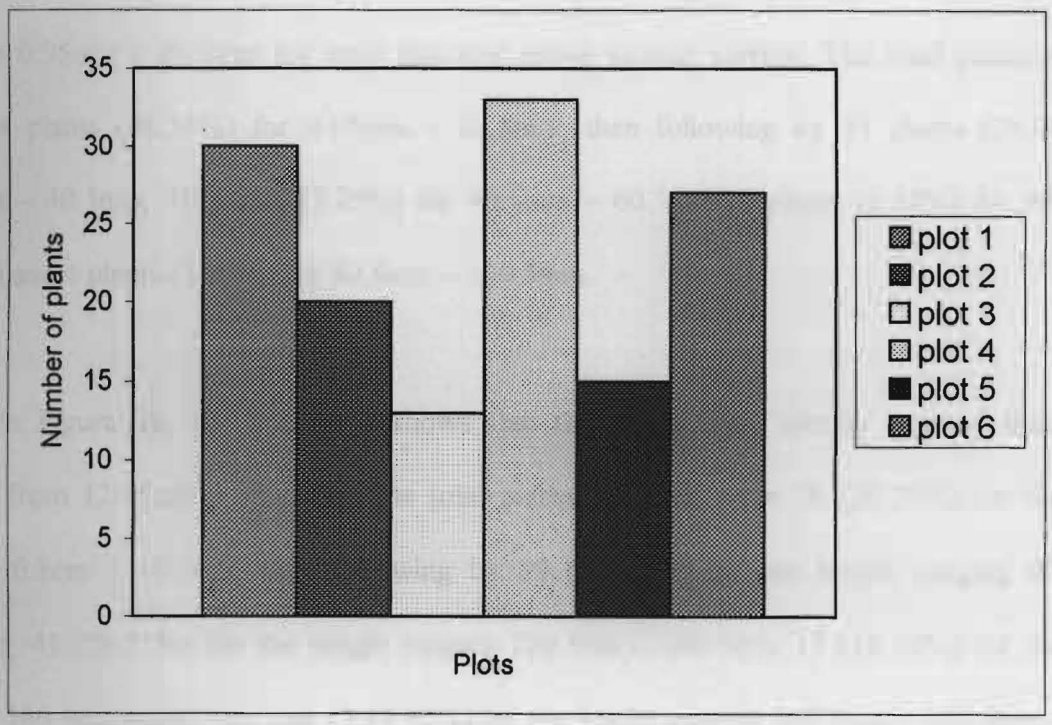


Figure 1 The total number of *A. borneensis* in each plot of one hectare surveyed at Gunung Gayu, Padawan.

Figure 2a shows that *A. borneensis* surveyed at Gunung Gayu were mostly ranged between 0.95mm – 20.5mm for stem diameter above ground surface. The total plants recorded were 64 plants (46.38%) for 0.95mm – 20.5mm, then following by 51 plants (36.96%) for 20.5mm – 40.5mm, 10 plants (7.25%) for 40.5mm – 60.5mm, 9 plants (6.52%) for 60.5mm – 80.5mm and 4 plants (2.90%) for 80.5mm – 100.5mm.

In Figure 2b, the histogram shows that the plants were mostly attained their height ranging from 120.5cm – 180.5cm. The total plants recorded were 28 (20.29%) for the height ranging 0.5cm – 60.5cm, then following by 39 (28.26%) for the height ranging 60.5cm – 120.5cm, 41 (29.71%) for the height ranging 120.5cm – 180.5cm, 17 (12.32%) for the height ranging 180.5cm – 240.5cm and 13 (9.42%) for the height ranging 240.5cm – 300.5cm. Among the 138 plants surveyed, the highest ground surface stem diameter recorded was 100mm or 10cm with its height of 210cm.

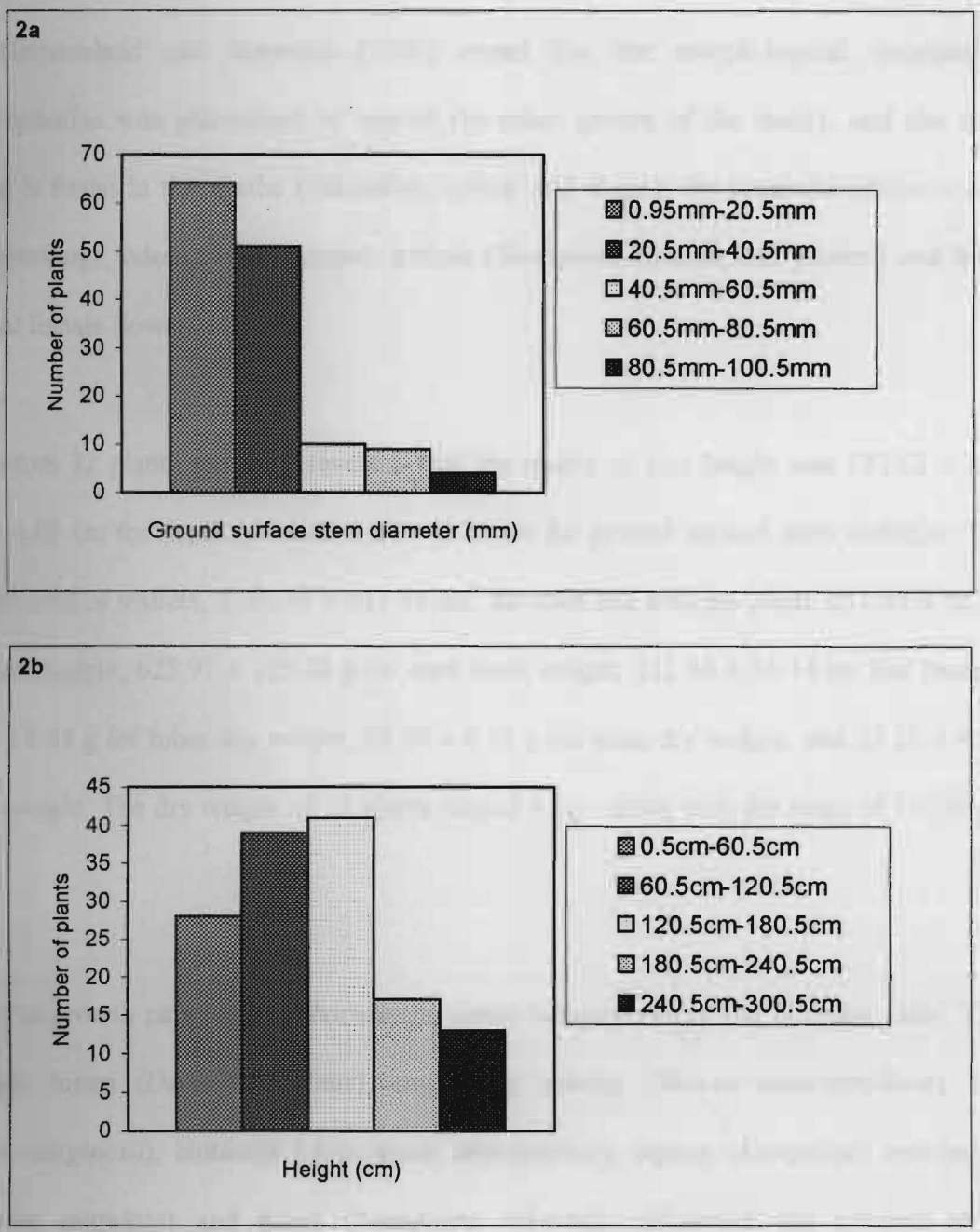


Figure 2 The distribution of the number of plants according to different ground surface stem diameter and of plant height.

Hetterscheid and Ittenbach (1996) stated that the morphological variation of the *Amorphophallus* was unmatched by any of the other genera of the family, and this excess of variation is found in the spathe (dimension, colour and shape), the appendix (dimension, shape, and sculpturing), odors, tuber (shape), petiole (dimension, colours and pattern) and finally the individual female flower.

From 32 plants sampled, revealed that the means of plot height was 132.62 ± 8.84 cm, 20.11 ± 1.03 cm for depth of tuber, 3.30 ± 0.28 cm for ground surface stem diameter, 128.28 ± 14.95 for total of leaflets, 6140.36 ± 921.91 cm^2 for total leaf area per plant, 251.03 ± 52.59 g for tuber fresh weight, 625.97 ± 125.28 g for stem fresh weight, 212.84 ± 34.14 for leaf fresh weight, 61.12 ± 15.13 g for tuber dry weight, 32.59 ± 6.51 g for stem dry weight, and 23.28 ± 4.06 g for leaf dry weight. The dry weight of 32 plants ranged 4.5g – 660g with the mean of 116.98g (Table 1).

The growth pattern of *A. borneensis* varied between plants and different plots. The large trees like durian (*Durio zibethinus*), engkabang jantung (*Shorea macrophyllum*), kemayau (*Santria rubiginosa*), bintawak (*Artocarpus anisophyllus*), tapang (*Kompassia excelsa*), ucung (*baccaurea angulata*) and kwini (*Mangifera odorata*), influenced the survival of the *A. borneensis*. From field observation, the *Amorphophallus* plants frequently occurred 2 – 4 meter from all these trees. It is possibly the *A. borneensis* grows better in moderate shading.

Mostly of the sampled plants was ranged between 120.5cm – 180.5cm height (Table 1). Tallest plant was recorded at 244.5cm with the ground surface stem diameter is 7cm and the total dry weight of 306.96g. Whereas the smallest plant recorded with the height of 47.0cm with the ground surface stem diameter of 0.903cm and the total dry weight was only 7.7g.

Table 1: The morphological characteristic of *A. borneensis* plants sampled from Gunung Gayu Padawan.

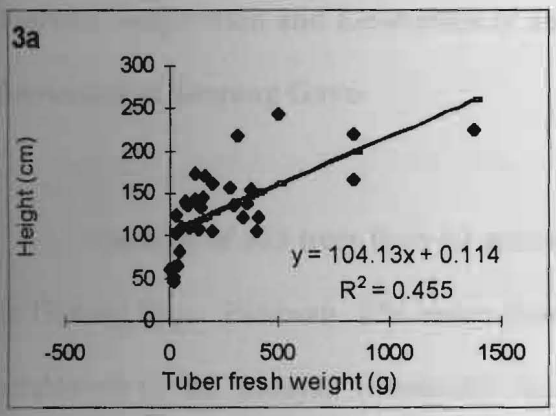
Plant number	Height (cm)	Depth of tuber (cm)	Ground surface stem diameter (cm)	Number of leaflets	Total Leaf area (cm^2)	Dry weight (g)		
						Tuber	Stem	Leaf
1	47.0	18.0	0.903	12	460	5.03	1.22	1.45
2	63.0	11.0	1.318	45	1348	3.09	2.53	3.93
3	109.0	18.0	2.129	57	2736	15.26	7.86	9.32
4	134.0	13.0	3.544	154	6055	35.91	21.58	23.09
5	122.0	20.0	2.912	79	3625	108.67	18.76	20.56
6	51.0	10.0	0.818	15	491	4.02	1.71	1.60
7	220.0	19.0	5.317	128	7117	230.72	77.83	38.11
8	136.0	15.0	3.372	163	5175	73.41	31.34	21.41
9	155.0	21.0	5.394	225	13931	76.03	52.41	25.56
10	138.0	30.0	3.371	149	4201	85.03	20.23	8.48
11	170.0	23.0	3.567	73	4626	45.00	35.51	9.69
12	144.0	22.0	3.069	104	4284	30.65	21.45	5.73
13	226.0	35.0	6.300	201	18474	420.25	145.91	93.92
14	156.5	25.0	3.530	99	9286	61.99	42.61	35.86
15	173.0	24.0	3.900	155	8302	26.73	31.75	34.32
16	140.0	30.0	3.400	117	6647	22.46	28.41	22.85
17	121.0	30.0	3.100	159	5968	97.88	23.83	22.71
18	167.0	23.0	4.700	254	7785	217.11	51.25	44.73
19	65.0	14.0	1.510	43	1471	12.55	4.75	4.16
20	83.0	18.0	1.400	18	926	17.50	5.12	2.86
21	244.5	26.0	7.000	312	24676	43.70	163.32	99.94
22	110.5	18.5	4.000	268	7932	21.06	33.96	30.03
23	144.5	21.0	4.200	194	9595	20.48	42.93	37.18
24	135.5	18.0	3.000	104	3793	22.28	15.38	14.42
25	105.5	20.0	2.500	109	4894	104.20	12.90	21.82
26	162.0	19.0	4.300	252	8388	26.14	45.25	31.95
27	124.5	15.0	3.000	127	5281	4.03	18.07	16.83
28	104.0	19.0	1.920	45	1981	2.81	8.83	5.44
29	108.5	17.0	2.400	75	2348	37.48	15.00	9.93
30	105.0	20.0	2.100	58	4193	45.06	12.53	14.90
31	216.8	20.0	6.300	283	9652	38.61	46.45	30.33
32	62.0	11.0	1.200	28	857	0.54	2.14	1.82
Mean	132.62	20.11	3.30	128.28	6140.56	61.12	32.59	23.28
Std. Error	8.85	1.03	0.28	14.95	921.91	15.13	6.51	4.06

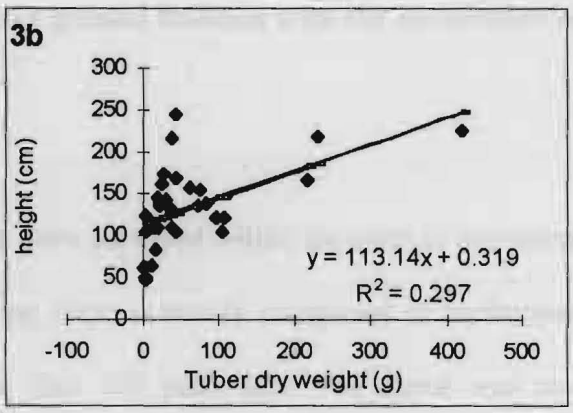
The determinations of leaf weight ratio (LWR), stem weight ratio (SWR), tuber weight ratio (TWR), specific leaf area (SLA) and leaf area ratio (LAR) are important in growth pattern of *A. borneensis*. The total dry weight of each 32 plants was not influenced the ratio of its weight (Table 2). The highest leaf weight ratio was 0.432 from sample 27, highest stem weight ratio was 0.532 from sample 21 and the highest of tuber weight ratio was 0.750 from sample 25. For specific leaf area, the highest number was 747.64cm^2/g from sample 12 while for the highest leaf area ratio was recorded as 141.15cm^2/g from sample 2.

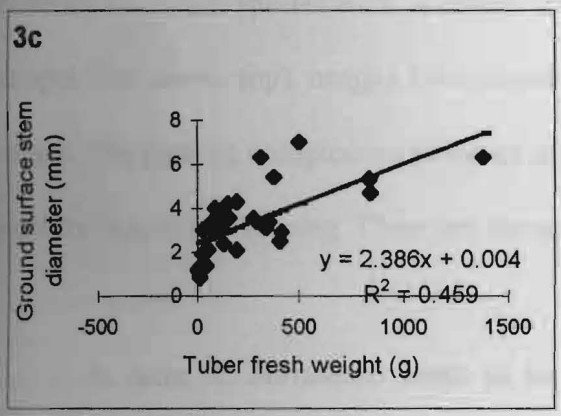
Table 2: The total dry weight, leaf weight ratio (LWR), stem weight ratio (SWR), tuber weight ratio (TWR), specific leaf area (SLA) and leaf area ratio (LAR) of *A. borneensis* at Gunung Gayu, Padawan.

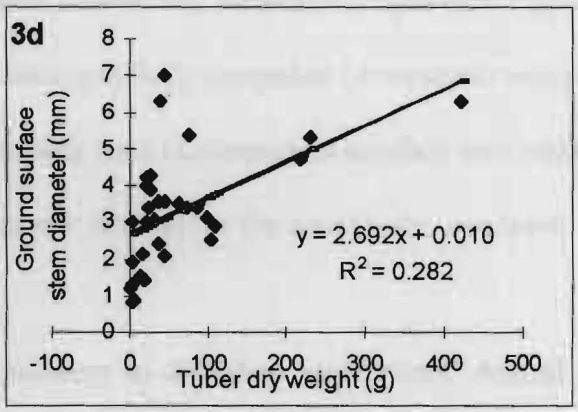
No. of Plant	Total Dry Weight	LWR	SWR	TLR	Leaf area (A)	SLA (cm2/g)	LAR (cm2/g)
1	7.70	0.188	0.158	0.653	460	317.24	59.74
2	9.55	0.412	0.265	0.324	1348	343.00	141.15
3	32.44	0.287	0.242	0.470	2736	293.56	84.34
4	80.58	0.287	0.268	0.446	6055	262.23	75.14
5	147.99	0.139	0.127	0.734	3625	176.31	24.49
6	7.33	0.218	0.233	0.548	491	306.88	66.98
7	346.66	0.110	0.225	0.666	7117	186.75	20.53
8	126.16	0.170	0.248	0.582	5175	241.71	41.02
9	154.00	0.166	0.340	0.494	13931	545.03	90.46
10	113.74	0.075	0.178	0.748	4201	495.40	36.94
11	90.20	0.107	0.394	0.499	4626	477.40	51.29
12	57.83	0.099	0.371	0.530	4284	747.64	74.08
13	660.08	0.142	0.221	0.637	18474	196.70	27.99
14	140.46	0.255	0.303	0.441	9286	258.95	66.11
15	92.80	0.370	0.342	0.288	8302	241.90	89.46
16	73.72	0.310	0.385	0.305	6647	290.89	90.17
17	144.42	0.157	0.165	0.678	5968	262.79	41.32
18	313.09	0.143	0.164	0.693	7785	174.04	24.87
19	21.46	0.194	0.221	0.585	1471	353.61	68.55
20	25.48	0.112	0.201	0.687	926	323.78	36.34
2	306.96	0.326	0.532	0.142	24676	246.91	80.39
22	85.05	0.353	0.399	0.248	7932	264.14	93.26
23	100.59	0.370	0.427	0.204	9595	258.07	95.39
24	52.08	0.277	0.295	0.428	3793	263.04	72.83
25	138.92	0.157	0.093	0.750	4894	224.29	35.23
26	103.34	0.309	0.438	0.253	8388	262.54	81.17
27	38.93	0.432	0.464	0.104	5281	313.78	135.65
28	17.08	0.319	0.517	0.165	1981	364.15	115.98
29	62.41	0.159	0.240	0.601	2348	236.46	37.62
30	72.49	0.206	0.173	0.622	4193	281.41	57.84
31	115.39	0.263	0.403	0.335	9652	318.23	83.65
32	4.50	0.404	0.476	0.120	857	470.88	190.40
Total	3743.43	7.516	9.508	14.980	196498	9999.71	2290.38
Mean	116.98	0.235	0.297	0.468	6141	312.49	71.57

The correlation between the vegetative parts of *A. borneensis* showed that the correlation between height and tuber fresh weight was $y = 104.13x + 0.114$ with $R^2 = 0.455$. Then $y = 113.14x + 0.319$ with $R^2 = 0.297$ for correlation between height and tuber dry weight (Figure 3b), $y = 2.386x + 0.004$ with $R^2 = 0.459$ for correlation between diameter and tuber fresh weight (Figure 3c), $y = 2.692x + 0.010$ with $R^2 = 0.282$ for correlation between diameter and tuber dry weight (Figure 3d) and $y = 34.41x + 29.80$ with $R^2 = 0.899$ for correlation between height and diameter (Figure 3e).









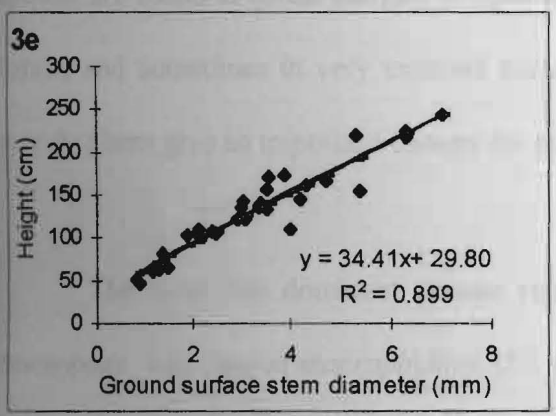


Figure 3 The correlation between parts of *A. borneensis*; 3a) Between height and tuber fresh weight, 3b) Between height and tuber dry weight, 3c) Between ground surface stem diameter and tuber fresh weight, 3d) Between ground surface stem diameter and tuber dry weight, and 3e) Between height and ground surface stem diameter.

Floristic composition and Estimation of above ground biomass with the occurrence of *A. borneensis* at Gunung Gayu

The total of 373 trees from 63 species were surveyed within six plots of one hectare each at Gunung Gayu, Padawan. The entire Gunung Gayu is mainly comprised of traditional orchad established by the Bidayuh community more than 100 years ago. The forest was mixture of common local fruit species such as durian (*Durio zibethinus*), rambutan (*Naphelium lappaceum*), tampoi (*Baccaurea* spp), nangka (*Artocarpus heterophyllus*), cempedak (*Artocarpus integer*), and others. The gigantic conspicuous presence of tapang trees (*Koompassia excelsa*) was traditionally kept for natural bee keeping. These are the economic activity for the people who live there.

In facts, *A. borneensis* seem to be pioneers in disturbed vegetations. Almost of this species are found at forest margin, in open forest, on (steep) slopes, in disturbed parts of primary forest, and sometimes in very exposed parts in limestone karst areas (Hetterschied, 1994). The woody plants give an important canopy for growth of *A. borneensis*.

The most five dominant species revealed in one hectare plot with the presence of A. *borneensis*, was *Shorea macrophyllum* (63 plants) with important value (IV) = 64.21. The range was followed by *Durio zibethinus* (21 plants) with IV = 21.87, *Baccaurea macrocarpa* (31 plants) with IV = 17.87, *Baccaurea angulata* (33 plants) with IV = 16.73, and *Koompassia excelsa* (5 plants) with IV = 15.18.

The total estimated above ground biomass was 164982.88kg/ha or 164.98 ton/ha (Table 3). The total estimation above ground biomass contributed the highest TAGB is *Shorea macrophyllum* (52736.31kg/ha), and then followed by *Koompassia excelsa* (39805.10kg/ha), *Durio zibethinus* (24264.16kg/ha), *Artocarpus anisophyllus* (5758.56kg/ha) and *Ganua kingiana* (5630.89kg/ha).

Table 3: The relative frequency (RF), relative density (Rd), relative of dominance (RD) and importance value (IV) of tree species with DBH ≥ 5cm at Gunung Gayu.

Spesies	Rd	Rf	RD	IV
Shorea macropyhllum	16.62	9.13	38.46	64.21
Durio zibethinus	5.54	5.39	10.94	21.87
Baccaurea macrocarpa	8.18	7.05	2.63	17.87
Baccaurea angulata	8.71	5.81	2.21	16.73
Koompassia excelsa	1.32	1.66	12.20	15.18
Lansium domesticum	5.80	4.56	1.81	12.18
Mangifera odorata	3.69	4.98	2.04	10.71
Santiria rubiginosa	4.75	4.15	0.84	9.74
Sandoricum koetjape	3.17	3.32	2.21	8.70
Ganua kingiana	2.11	1.24	3.88	7.23
Garcinia bancana	1.85	2.90	2.25	7.00
Eusideroxylon zwageri	2.90	2.49	1.10	6.50
Artocarpus anisophyllus	1.06	1.24	3.14	5.44
Artocarpus integer	1.58	2.07	1.64	5.29
Ficus aurata	2.11	2.49	0.59	5.19
Xanthophyllum affine	1.58	1.66	1.93	5.17
Cleistanilus coriaceus	1.58	2.49	0.47	4.55
Hevea brasilliensis	1.85	2.07	0.39	4.31
Dacryodes rostrata	1.58	0.41	1.75	3.75
Dracontomelon dao	1.06	1.24	0.89	3.19
Baccaurea motleyana	1.06	1.66	0.30	3.01
Artocarpus dadah	1.06	1.66	0.13	2.85
Ardisia polyactis	1.06	1.66	0.07	2.79
Nephelium cappaceum	1.06	1.24	0.48	2.78
Artocarpus odoratissimas	0.26	0.41	1.95	2.63

Eleocarpus sp.	0.79	1.24	0.45	2.49
Knema intermedia	1.06	1.24	0.15	2.45
Diospyros siamang	0.79	1.24	0.38	2.41
Bhesa paniculata	0.79	1.24	0.34	2.37
Mallotus leucodermis	1.06	0.83	0.21	2.09
Euodia malayana	0.26	0.41	1.14	1.81
Eugenia sp.	0.79	0.83	0.16	1.79
Litsea nidularis	0.53	0.83	0.43	1.79
Artocarpus sarawakensis	0.53	0.83	0.12	1.48
Artocarpus nitidus	0.53	0.83	0.11	1.47
Aporusa symplocoides	0.53	0.83	0.06	1.42
Polyalthia cauliflora	0.53	0.83	0.06	1.42
Ardisia syneura	0.53	0.83	0.05	1.41
Scolopia spinosa	0.53	0.83	0.04	1.40
Sambal	0.53	0.83	0.03	1.39
Polyalthia glauca	0.53	0.83	0.03	1.39
Gluta sp.	0.53	0.83	0.03	1.38
Grewia omphacarpa	0.53	0.41	0.25	1.19
Adinandra dimosa	0.53	0.41	0.08	1.02
Artocarpus komando	0.26	0.41	0.16	0.84
Palaqium gufa	0.26	0.41	0.10	0.78
Dillenia excelsa	0.26	0.41	0.10	0.77
Myristica malaceensis	0.26	0.41	0.06	0.74
Alstonia scholaris	0.26	0.41	0.06	0.74
Memecylon paniculatum	0.26	0.41	0.06	0.74
Monocarpia manginalis	0.26	0.41	0.05	0.73
Pometia pinnata	0.26	0.41	0.04	0.72
Neolamarckia cadamba	0.26	0.41	0.04	0.72
Artocarpus elasticus	0.26	0.41	0.04	0.72
Horsefieldia grandis	0.26	0.41	0.03	0.71
Fordia coriacea	0.26	0.41	0.03	0.71
Alseodapha	0.26	0.41	0.03	0.71
Canthium diadenum	0.26	0.41	0.02	0.70
Symplocos sp.	0.26	0.41	0.02	0.70
Dendrocynide stimularis	0.26	0.41	0.02	0.70
Aglaia sp.	0.26	0.41	0.02	0.70
Shorea gibosa	0.26	0.41	0.01	0.69
Shorea leprosula	0.26	0.41	0.01	0.69

Table 4: The basal area (BA), leaf area index (LAI) and biomass of the tree species with DBH ≥ 5cm at Gunung Gayu.

Species	Total individual trees	Average DBH (cm)	BA (cm^2)	LAI (cm^2)	Ws (kg)	WB (kg)	WL (kg)	Biomass (kg/ha)
rea macropyhllum	63	49.6	89461.73	2076.49	42896.19	9594.18	245.95	52736.31
ompassia excelsa	5	94	28383.26	1712.65	32462.51	7142.17	200.43	39805.1
rio zibethinus	21	15.4	25442.74	1220.22	19876.11	4248.24	139.81	24264.16
ocarpus odoratissimas	1	76	4534.16	455.44	4771.91	937.59	49.07	5758.56
nua kingiana	8	39	9023.18	448.49	4666.87	915.74	48.27	5630.89
ocarpus anisophyllus	4	55	7309.62	427	4346.5	849.31	45.82	5241.63
idoricum koetjape	12	24.1	5141.89	299.75	2603.45	493.56	31.46	3128.47
ngifera odorata	14	10.6	4736.25	272.37	2266.15	426.12	28.42	2720.68
cryodes rostrata	6	40.9	4076.91	259.22	2109.35	394.96	26.96	2531.27
ccaurea macrocarpa	31	14.18	6129.21	255.64	2067.34	386.63	26.57	2480.54
rcinia bancana	7	34.5	5238.66	252.26	2027.81	378.81	26.19	2432.81
nthophyllum affine	6	22.38	4481.05	224.96	1717.77	317.76	23.19	2058.73
ocarpus integer	6	34.6	3806.94	218.75	1649.47	304.4	22.51	1976.38
nsium domesticum	22	18.1	4202.87	191.22	1357.37	247.63	19.51	1624.51
ccaurea angulata	33	12.8	5151.56	177.6	1219.51	221.08	18.04	1458.63
sideroxylon zwageri	11	12	2568.46	177.47	1218.22	220.83	18.03	1457.08
acontomelon dao	4	5.6	2072.25	176.8	1211.64	219.57	17.95	1449.16
odia malayana	1	58	2640.74	169.77	1142.39	206.3	17.2	1365.89
ntiria rubiginosa	18	8.5	1947.89	118.2	675.98	118.35	11.71	806.03
sea nidularis	2	31	994.79	102.08	546.57	94.5	10.02	651.09
ocarpus sp.	3	16.5	1054.93	100.98	537.99	92.93	9.9	640.82
us aurata	8	5.5	1373.79	95.23	494.16	84.93	9.3	588.4
phelium cappaceum	4	7.3	1112.91	90.78	461.08	78.93	8.84	548.85
istanilus coriaceus	6	8.8	1101.65	78.1	370.73	62.65	7.54	440.91
esa paniculata	3	21.4	781.77	66.4	292.96	48.82	6.34	348.13
spyros siamang	3	10.1	878.9	61.74	263.63	43.66	5.87	313.16
yea brasilliensis	7	6.9	901.88	57.94	240.46	39.61	5.49	285.56
ccaurea motleyana	4	10.5	687.32	57.35	236.88	38.99	5.43	281.29
ewia omphacarpa	2	15.7	573.43	52.39	207.78	33.93	4.93	246.64
llotus leucodermis	4	16.5	486.19	47.72	181.45	29.4	4.47	215.31
ocarpus komando	1	22	379.94	45.7	170.43	27.51	4.26	202.2
genia sp.	3	18.5	381.09	36.39	122.49	19.39	3.35	145.23
ocarpus nitidus	2	14.3	264.34	30	92.53	14.41	2.73	109.66